

Amendments to the Claims

This listing will replace all prior versions and listings of claims in the application:

Listing of Claims

1. (original) A first method of depositing a film of a metal chalcogenide, comprising the steps of:

contacting: at least one metal chalcogenide; a hydrazine compound represented by the formula:



wherein each of R^1 , R^2 , R^3 and R^4 is independently selected from the group consisting of: hydrogen, aryl, methyl, ethyl and a linear, branched or cyclic alkyl of 3-6 carbon atoms; and optionally, an elemental chalcogen selected from the group consisting of: S, Se, Te and a combination thereof; to produce a solution of a hydrazinium-based precursor of said metal chalcogenide;

applying said solution of said hydrazinium-based precursor of said metal chalcogenide onto a substrate to produce a film of said precursor; and thereafter

annealing said film of said precursor to remove excess hydrazine and hydrazinium chalcogenide salts to produce a metal chalcogenide film on said substrate.

2. (original) The method of claim 1, wherein said metal chalcogenide comprises a metal selected from the group consisting of: Ge, Sn, Pb, Sb, Bi, Ga, In, Tl and a combination thereof and a chalcogen selected from the group consisting of: S, Se, Te and a combination thereof.

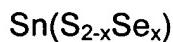
3. (original) The method of claim 1, wherein said metal chalcogenide is represented by the formula MX or MX₂ wherein M is a metal selected from the group consisting of: Ge, Sn, Pb and a combination thereof; and wherein X is a chalcogen selected from the group consisting of: S, Se, Te and a combination thereof.

4. (original) The method of claim 1, wherein said metal chalcogenide is represented by the formula M₂X₃ wherein M is a metal selected from the group consisting of: Sb, Bi, Ga, In and a combination thereof; and wherein X is a chalcogen selected from the group consisting of: S, Se, Te and a combination thereof.

5. (original) The method of claim 1, wherein said metal chalcogenide is represented by the formula M₂X wherein M is Tl; and wherein X is a chalcogen selected from the group consisting of: S, Se, Te and a combination thereof.

6. (original) The method of claim 1, wherein said metal is selected from the group consisting of: Sn and Sb; and wherein said chalcogen is selected from the group consisting of: S and Se.

7. (original) The method of claim 6, wherein said chalcogenide is represented by the formula:



wherein x is from 0 to 2.

8. (original) The method of claim 1, wherein each of R¹, R², R³ and R⁴ is independently selected from the group consisting of: hydrogen, aryl, methyl and ethyl.

9. (original) The method of claim 1, wherein R¹, R², R³ and R⁴ are hydrogen.

10. (original) The method of claim 1, wherein said metal chalcogenide film is in the form of a thin film.

11. (original) The method of claim 1, wherein said metal chalcogenide film comprises a polycrystalline metal chalcogenide or single crystals of said metal chalcogenide.

12. (original) The method of claim 11, wherein said polycrystalline metal chalcogenide has a grain size equal to or greater than the dimensions between contacts in a semiconductor device.

13. (original) The method of claim 1, wherein said annealing step is carried out at a temperature and for a length of time sufficient to produce said metal chalcogenide film.

14. (original) The method of claim 1, wherein said substrate is selected from the group consisting of:

Kapton, silicon, amorphous hydrogenated silicon, silicon carbide (SiC), silicon dioxide (SiO_2), quartz, sapphire, glass, metal, diamond-like carbon, hydrogenated diamond-like carbon, gallium nitride, gallium arsenide, germanium, silicon-germanium, indium tin oxide, boron carbide, boron nitride, silicon nitride (Si_3N_4), alumina (Al_2O_3), cerium(IV) oxide (CeO_2), tin oxide (SnO_2), zinc titanate (ZnTiO_2), a plastic material and a combination thereof.

15. (original) A film prepared by the method of claim 1.

16. (original) A second method of depositing a film of a metal chalcogenide, comprising the steps of:

contacting: at least one metal chalcogenide and a salt of an amine compound with H₂S, H₂Se or H₂Te, wherein said amine compound is represented by the formula:



wherein each of R⁵, R⁶ and R⁷ is independently selected from the group consisting of: hydrogen, aryl, methyl, ethyl and a linear, branched or cyclic alkyl of 3-6 carbon atoms, to produce an ammonium-based precursor of said metal chalcogenide;

contacting said ammonium-based precursor of said metal chalcogenide, a hydrazine compound represented by the formula:



wherein each of R¹, R², R³ and R⁴ is independently selected from the group consisting of: hydrogen, aryl, methyl, ethyl and a linear, branched or cyclic alkyl of 3-6 carbon atoms, and optionally, an elemental chalcogen selected from the group consisting of: S, Se, Te and a combination thereof; to produce a solution of a hydrazinium-based precursor of said metal chalcogenide in said hydrazine compound;

applying said solution of said hydrazinium-based precursor of said metal chalcogenide onto a substrate to produce a film of said precursor; and thereafter

annealing said film of said precursor to remove excess hydrazine and hydrazinium chalcogenide salts to produce a metal chalcogenide film on said substrate.

17. (original) The method of claim 16, wherein said metal chalcogenide comprises a metal selected from the group consisting of: Ge, Sn, Pb, Sb, Bi, Ga, In, Tl and a combination thereof and a chalcogen selected from the group consisting of: S, Se, Te and a combination thereof.

18. (original) The method of claim 16, wherein each of R¹, R², R³, R⁴, R⁵, R⁶ and R⁷ is independently selected from the group consisting of: hydrogen, aryl, methyl and ethyl.

19. (original) The method of claim 16, wherein R¹, R², R³, R⁴, R⁵, R⁶ and R⁷ are hydrogens.

20. (original) The method of claim 16, wherein said metal chalcogenide film is in the form of a thin film.

21. (original) The method of claim 16, wherein said metal chalcogenide film comprises a polycrystalline metal chalcogenide or single crystals of said metal chalcogenide.

22. (original) The method of claim 21, wherein said polycrystalline metal chalcogenide has a grain size equal to or greater than the dimensions between contacts in a semiconductor device.

23. (original) The method of claim 16, wherein said annealing step is carried out at a temperature and for a length of time sufficient to produce said metal chalcogenide film.

24. (original) The method of claim 16, wherein said substrate is selected from the group consisting of:

Kapton, silicon, amorphous hydrogenated silicon, silicon carbide (SiC), silicon dioxide (SiO₂), quartz, sapphire, glass, metal, diamond-like carbon, hydrogenated diamond-like carbon, gallium nitride, gallium arsenide, germanium, silicon-germanium, indium tin oxide, boron carbide, boron nitride, silicon nitride (Si₃N₄), alumina (Al₂O₃), cerium(IV) oxide (CeO₂), tin oxide (SnO₂), zinc titanate (ZnTiO₂), a plastic material and a combination thereof.

25. (original) A film prepared by the method of claim 16.

26. (original) A method of preparing an improved field-effect transistor of the type having a source region and a drain region, a channel layer extending between the source region and the drain region, the channel layer including a semiconducting material, a gate region disposed in spaced adjacency to the channel layer, an electrically insulating layer between the gate region and the source region, drain region and channel layer, wherein the improvement comprises:

preparing a channel layer comprising a film of a metal chalcogenide semiconducting material by a first or second method;

wherein said first method comprises the steps of:

contacting: at least one metal chalcogenide; a hydrazine compound represented by the formula:



wherein each of R¹, R², R³ and R⁴ is independently selected from the group consisting of: hydrogen, aryl, methyl, ethyl and a linear, branched or cyclic alkyl of 3-6 carbon atoms; and optionally, an elemental chalcogen selected from the group consisting of: S, Se, Te and a combination thereof; to produce a solution of a hydrazinium-based precursor of said metal chalcogenide;

applying said solution of said hydrazinium-based precursor of said metal chalcogenide onto a substrate to produce a film of said precursor; and thereafter

annealing said film of said precursor to remove excess hydrazine and hydrazinium chalcogenide salts to produce a metal chalcogenide film; and

wherein said second method comprises the steps of:

contacting: at least one metal chalcogenide and a salt of an amine compound with H₂S, H₂Se or H₂Te, wherein said amine compound is represented by the formula:



wherein each of R⁵, R⁶ and R⁷ is independently selected from the group consisting of: hydrogen, aryl, methyl, ethyl and a linear, branched or cyclic alkyl of 3-6 carbon atoms, to produce an ammonium-based precursor of said metal chalcogenide;

contacting said ammonium-based precursor of said metal chalcogenide, a hydrazine compound represented by the formula:



wherein each of R¹, R², R³ and R⁴ is independently selected from the group consisting of: hydrogen, aryl, methyl, ethyl and a linear, branched or cyclic alkyl of 3-6 carbon atoms, and optionally, an elemental chalcogen selected from the group consisting of: S, Se, Te and a combination thereof, to produce a solution of a hydrazinium-based precursor of said metal chalcogenide in said hydrazine compound;

applying said solution of said hydrazinium-based precursor of said metal chalcogenide onto a substrate to produce a film of said precursor; and thereafter annealing said film of said precursor to remove excess hydrazine and hydrazinium chalcogenide salts to produce a metal chalcogenide film on said substrate.

27. (original) The method of claim 26, wherein said source region, channel layer and drain region are disposed upon a surface of a substrate, said electrically insulating layer is disposed over said channel layer and extending from said source region to said drain region, and said gate region is disposed over said electrically insulating layer.

28. (original) The method of claim 26, wherein said gate region is disposed as a gate layer upon a surface of a substrate, said electrically insulating layer is disposed upon said gate layer, and said source region, channel layer, and drain region are disposed upon said electrically insulating layer.

29. (original) The method of claim 26, wherein said metal chalcogenide film is in the form of a thin film.

30. (original) The method of claim 29, wherein said thin film has a thickness of from about 5 Å to about 2,000 Å.

31. (original) The method of claim 26, wherein said metal chalcogenide film comprises a polycrystalline metal chalcogenide or single crystals of said metal chalcogenide.

32. (original) The method of claim 31, wherein said metal chalcogenide film is polycrystalline with a grain size equal to or greater than the dimensions between contacts in a semiconductor device.

33. (original) The method of claim 26, wherein said metal chalcogenide comprises a metal selected from the group consisting of: Ge, Sn, Pb, Sb, Bi, Ga, In, Tl and a combination thereof and a chalcogen selected from the group consisting of: S, Se, Te and a combination thereof.

34. (original) The method of claim 26, wherein each of R¹, R², R³, R⁴, R⁵, R⁶ and R⁷ is independently selected from the group consisting of: hydrogen, aryl, methyl and ethyl.

35. (original) The method of claim 34, wherein R¹, R², R³, R⁴, R⁵, R⁶ and R⁷ are hydrogens.

36. (original) The method of claim 26, wherein said annealing step is carried out at a temperature and for a length of time sufficient to produce said metal chalcogenide film.

37. (original) The method of claim 36, wherein said temperature is from about 25 °C to about 500 °C.

38. (original) The method of claim 37, wherein said temperature is from about 250 °C to about 350 °C.

39. (original) The method of claim 26, wherein said substrate is selected from the group consisting of:

Kapton, silicon, amorphous hydrogenated silicon, silicon carbide (SiC), silicon dioxide (SiO_2), quartz, sapphire, glass, metal, diamond-like carbon, hydrogenated diamond-like carbon, gallium nitride, gallium arsenide, germanium, silicon-germanium, indium tin oxide, boron carbide, boron nitride, silicon nitride (Si_3N_4), alumina (Al_2O_3), cerium(IV) oxide (CeO_2), tin oxide (SnO_2), zinc titanate (ZnTiO_2), a plastic material and a combination thereof.

40. (original) An improved field-effect transistor prepared by the method of claim 26.

-- 41. (new) A field-effect transistor comprising a channel layer having a metal chalcogenide film prepared by a method comprising steps of:

contacting at least one metal chalcogenide and (i) a hydrazine compound or (ii) first an ammonium salt compound and thereafter a hydrazine compound, to produce a solution of a hydrazinium-based precursor of said metal chalcogenide;

applying said solution of said hydrazinium-based precursor of said metal chalcogenide onto a substrate to produce a film of said precursor; and

annealing said film of said precursor under conditions sufficient to produce said metal chalcogenide film.

42. (new) The method of claim 41, wherein said a hydrazine compound is represented by the formula:



wherein each of R^1 , R^2 , R^3 and R^4 is independently selected from the group consisting of: hydrogen, aryl, methyl, ethyl and a linear, branched or cyclic alkyl of 3-6 carbon atoms.

43. (new) The method of claim 41, wherein said conditions sufficient to produce said metal chalcogenide film comprise a temperature from about 25 °C to about 500 °C.

44. (new) A method of preparing a metal chalcogenide film in a field-effect transistor, comprising steps of:

contacting at least one metal chalcogenide and (i) a hydrazine compound or (ii) first an ammonium salt compound and thereafter a hydrazine compound to produce a solution of a hydrazinium-based precursor of said metal chalcogenide;

applying said solution of said hydrazinium-based precursor of said metal chalcogenide onto a substrate to produce a film of said precursor; and

annealing said film of said precursor under conditions sufficient to produce said metal chalcogenide film.

45. (new) The method of claim 44, wherein said a hydrazine compound is represented by the formula:



wherein each of R¹, R², R³ and R⁴ is independently selected from the group consisting of: hydrogen, aryl, methyl, ethyl and a linear, branched or cyclic alkyl of 3-6 carbon atoms.

46. (new) The method of claim 44, wherein said conditions sufficient to produce said metal chalcogenide film comprise a temperature from about 25 °C to about 500 °C. --